MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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WILLIAM LASSELL, Esq., President, in the Chair.

F. W. Levander, Esq., University College, London;
Wm. Mann, Esq., Royal Observatory, Cape of Good Hope; and
E. W. Snell, Esq., Kidbrook House Academy, Blackheath;

were balloted for and duly elected Fellows of the Society.

On the Total Eclipse of the Sun, on December the 11*th*, 1871, *as visible in the Madras Presidency.* By C. Ragoonathachary, First Assistant, Madras Observatory.

(*Communicated by N. R. Pogson, Esq., Government Astronomer.*)

Herewith I have the honour to submit to the Royal Astronomical Society the results of my calculations with reference to the Total Eclipse of the Sun, which will take place on the 11th December, 1871. Though the duration of this eclipse will be considerably shorter than that of 1868, yet I presume that so favourable an opportunity will not be suffered to pass away without adequate preparation for due record of all the important and interesting phenomena which present themselves for investigation on such occasions.

The central line of the eclipse will first meet the Earth's surface in the Arabian Sea, and entering on the western coast of India, will pass right across one of the most important parts of

Hindustan, in a S.E. by E. direction. In this part of the Peninsula the Sun will be about 20° above the horizon when totally obscured. The duration of totality will be two minutes and a quarter, and the breadth of the shadow about seventy miles. On leaving the eastern coast of the Madras Presidency, the central line will cross Palk's Straits, passing about ten miles S.W. of the island Jaffnapatam, and over the northern part of Ceylon, where the small towns of Moeletivoe and Kokelay will lie near the central line; and also the well-known naval station of Trincomalee, which will be about fifteen miles S.W. of the line. Continuing its course over the Bay of Bengal, the shadow will cross the S.E. point of Sumatra, and will touch the south-western coast of Java, where Batavia, the capital, will lie nearly sixty miles N.E. of the central line; and two other smaller towns, Chidamar and Nagara, will also be very near the middle of the shadow path. In the Admiralty Gulf, on the N.W. coast of Australia, the eclipsed Sun will be only ten degrees past the meridian, and not far from the zenith; in consequence of which the totality will last $4^m\ 18^s$, or only four seconds less than the time of greatest duration. Lastly, passing through the most barren and uninhabited portion of Australia, crossing the Gulf of Carpentaria and the York Peninsula, the shadow will ultimately leave the Earth's surface in the Pacific Ocean.

The following are the geographical positions of the central and limiting lines of the shadow, together with other details of calculation, applicable to Southern India, for intervals of fifteen seconds of Greenwich mean time. They are almost identical with the values obtained by interpolation, from the similar table furnished on page 441 of the *Nautical Almanac* for the year 1871.

Greenwich M.T.	Northern Limit. North Latitude	Northern Limit. East Longitude.	Central Line. North Latitude.	Central Line. East Longitude.	Southern Limit. North Latitude.	Southern Limit. East Longitude.
h m s	° ′	° ′	° ′	° ′	° ′	° ′
14 25 45	13 1	74 58	12 36	74 42	12 12	74 24
14 26 0	12 48	75 22	12 23	75 6	11 59	74 48
14 26 15	12 35	75 46	12 10	75 30	11 46	75 12
14 26 30	12 23	76 9	11 58	75 53	11 33	75 35
14 26 45	12 11	76 31	11 46	76 15	11 21	75 57
14 27 0	11 59	76 53	11 34	76 37	11 9	76 19
14 27 15	11 47	77 14	11 22	76 58	10 58	76 40
14 27 30	11 36	77 35	11 11	77 18	10 46	77 0
14 27 45	11 25	77 55	11 0	77 38	10 35	77 20
14 28 0	11 14	78 14	10 49	77 57	10 24	77 39
14 28 15	11 4	78 33	10 38	78 16	10 13	77 58
14 28 30	10 53	78 51	10 28	78 34	10 3	78 16
14 28 45	10 43	79 9	10 18	78 52	9 52	78 34
14 29 0	10 33	79 27	10 8	79 10	9 42	78 51
14 29 15	10 23	79 44	9 58	79 27	9 32	79 8

On the Central Line.

Greenwich M.T.	Sun's Altitude above the Horizon.	Excess of the Sun's App. Diameter above that of the Earth.	Relative Motion of Sun in one minute of Time.	Duration of Totality.
h m s	°	″	″	m s
14 25 45	17	65·6	31·0	2 7
14 26 0	17	65·9	30·9	2 8
14 26 15	17	66·2	30·8	2 9
14 26 30	18	66·5	30·7	2 10
14 26 45	18	66·7	30·7	2 11
14 27 0	19	66·9	30·6	2 11
14 27 15	19	67·1	30·5	2 12
14 27 30	19	67·3	30·4	2 13
14 27 45	20	67·5	30·3	2 14
14 28 0	20	67·7	30·2	2 14
14 28 15	20	67·9	30·1	2 15
14 28 30	21	68·1	30·1	2 16
14 28 45	21	68·3	30·0	2 17
14 29 0	21	68·5	29·9	2 17
14 29 15	22	68·7	29·8	2 18

The principal places in the Madras Presidency, situated near the northern limit of the shadow, and their direct distances therefrom in miles, will be as follows:—

Districts.	Places.	Miles.
South Canara	Mangalore	11 within
,,	Oopin Ungadi	upon
Coorg	Mercara	9 within
Mysore	Honsoor	upon
Astragam Division	Mysore	13 beyond
Coimbatore	Sattimangulum	14 within
,,	Bowani	4 within
,,	Yirodu	8 within
Salem	Trichungode	upon
,,	Salem	24 beyond
,,	Namcul	upon
Trichinopoly	Moosery	7 within
,,	Trichinopoly	8 within
Tanjore	Tanjore	5 beyond
,,	Puttoocattay	10 within
,,	Point Calmere	upon

Places most favourably situated on or near the central

line, with their geographical positions and direct distances therefrom:—

Districts.	Places.	North Latitude. ° ′	East Longitude. ° ′	Miles.
South Canara	Kassergode	12 30	75 1	5 N
,,	Baicull	12 24	75 4	upon
Coorg	Veerajunderpetta	12 13	75 52	16 N
Malabar	Gunote	12 0	75 45	2 S
,,	Manuntoddy	11 48	76 5	1 S
,,	Goodaloor	11 30	76 32	5 S
On the Neelgherries	Ootacamund	11 25	76 43	6 S
	Dodabetta	11 23	76 47	5 S
	Wellington	11 23	76 46	6 S
	Coonoor	11 21	76 52	5 S
	Kotagherry	11 24	76 56	2 N
Coimbatore	Sivamogay	11 20	77 5	2 N
,,	Avenasi	11 12	77 19	2 N
,,	Tirrupur	11 5	77 24	2 S
,,	Kangyam	11 1	77 37	upon
,,	Darapoorum	10 44	77 35	18 S
,,	Vellacoil	10 57	77 46	2 S
,,	Chinna Darapoorum	10 51	77 55	1 N
,,	Caroor	10 57	78 8	14 N
Madura	Veerallimalli	10 34	78 37	10 N
,,	Iluppur	10 31	78 41	5 N
,,	Poodoocottah	10 23	78 53	5 N
Tanjore	Ardangi	10 11	79 3	1 S
,,	Manamalgudi	10 3	79 16	2 S

And, lastly, for places near the southern limit of the shadow we shall have,—

Districts.	Places.	Miles.
Malabar	Cannanore	14 within
,,	Tellicherry	10 within
,,	Mahe	9 within
,,	Calicut	10 beyond
,,	Beyapur	15 beyond
,,	Palghaut	10 beyond
Coimbatore	Coimbatore	14 within
,,	Polachy	4 beyond
,,	Chuckragherry	8 beyond
Madura	Pulney	upon
,,	Dindigul	11 within
,,	Madura	9 beyond

Districts.	Places.	Miles.
Madura	Shevagunga	1 beyond
,,	Ramnaud	20 beyond
,,	Autencurray	16 beyond
,,	Ramaswarum	8 beyond

The calculation of the different phenomena of the eclipse was made accurately for Avenasi, a railway station situated midway between the two coasts, on the central line; and for the Madras and Trevandrum Observatories, which lie respectively at some distance north and south of the shadow. The usual equations of reduction applicable to places near the above three points are also given; in which l denotes geocentric north latitude, λ_Δ east longitude for Madras, and t the Madras mean time of each phenomenon. The results of the calculations are:—

For Madras.

Lat. 13° 4′·1 N.; Long. 80° 14′·3 E. of Greenwich.

	Madras Mean Time.
	d h m s
Time of first contact	Dec. 11 18 47 37
Time of greatest obscuration	19 49 32
Time of last contact	20 59 59
Duration of the eclipse	2 12 22
	° ′
Angle from north point, of { First contact	73 33 West.
Angle from north point, of { Last contact	119 9 East.
Angle from the Sun's vertex, of { First contact	1 19 Right.
Angle from the Sun's vertex, of { Last contact	173 33 Left.
Magnitude of the eclipse (Sun's diameter = 1)	0·9165
Limb of the Sun eclipsed	South.

Formulæ for Reduction to different places near Madras.

First Contact.

$$\text{Cos } w = -0\cdot2214 - [0\cdot20128] \sin l - [9\cdot98190] \cos l \cos (\lambda_\Delta - 121^\circ\ 15'\cdot5)$$

$$t = 21^h\ 35^m\ 36^s - [3\cdot55274] \sin w - [3\cdot35619] \sin l - [3\cdot79315] \cos l \cos (\lambda_\Delta + 6^\circ\ 24'\cdot3)$$

Greatest Phase.

$$\text{Cos } w = -0\cdot0382 - [0\cdot19815] \sin l - [9\cdot99342] \cos l \cos (\lambda_\Delta - 107^\circ\ 48'\cdot3)$$

$$t = 21^h\ 45^m\ 3^s - [3\cdot42904] \sin l - [3\cdot84182] \cos l \cos (\lambda_\Delta + 20^\circ\ 47'\cdot6)$$

$$\text{Magnitude of the eclipse} = 1\cdot0175 - (1\cdot0175 \cos w)$$

Last Contact.

$$\text{Cos } w = 0\cdot2244 - [0\cdot19578] \sin l - [0\cdot00173] \cos l \cos (\lambda_\Delta - 92^\circ\ 3'\cdot4)$$

$$t = 21^h\ 38^m\ 9^s + [3\cdot65898] \sin w - [3\cdot49952] \sin l - [3\cdot89599] \cos l \cos (\lambda_\Delta + 37^\circ\ 3'\cdot3)$$

For Avenasi.

Lat. 11° 12′ N.; Long. $\begin{cases} 77^\circ\ 19'{\cdot}0 & \text{E. of Greenwich.} \\ 2\ 55{\cdot}3 & \text{W. of Madras.} \end{cases}$

	Madras Mean Time. d h m s	Local Mean Time. h m s
Time of first contact	Dec. 11 18 47 33	= 18 35 52
Beginning of the total phase ..	19 47 19	= 19 35 38
Middle of totality	19 48 26	= 19 36 44
Ending of the total phase ..	19 49 32	= 19 37 51
Time of last contact	20 57 31	= 20 45 50

	h m s
Duration of the Eclipse	2 9 58
Duration of totality	0 2 13

Angle from north point, of	First contact	68° 8′ West.
	Last contact	113 26 East.
Angle from the Sun's vertex,	First contact	7 3 Left.
	Last contact	171 44 Left.

Formulæ for Reduction to different places near Avenasi.

First Contact.

$$\text{Cos } w = -0{\cdot}2075 - [0{\cdot}20204] \sin l - [9{\cdot}97944] \cos l \cos (\lambda_\Delta - 120^\circ\ 51'{\cdot}1)$$

$$t = 21^h\ 32^m\ 10^s - [3{\cdot}54328] \sin w - [3{\cdot}34120] \sin l - [3{\cdot}78431] \cos l \cos (\lambda_\Delta + 6^\circ\ 32'{\cdot}3)$$

Middle of Totality.

$$\text{Cos } w = -1{\cdot}9887 - [1{\cdot}96825] \sin l - [1{\cdot}76185] \cos l \cos (\lambda_\Delta - 107^\circ\ 36'{\cdot}0)$$

$$t = 21^h\ 42^m\ 37^s - [3{\cdot}41653] \sin l - [3{\cdot}83247] \cos l \cos (\lambda_\Delta + 20^\circ\ 51'{\cdot}7)$$

Semi-duration of totality $= [1{\cdot}82258] \sin w$.

Last Contact.

$$\text{Cos } w = 0{\cdot}2277 - [0{\cdot}19709] \sin l - [9{\cdot}99844] \cos l \cos (\lambda_\Delta - 91^\circ\ 31'{\cdot}4)$$

$$t = 21^h\ 37^m\ 24^s + [3{\cdot}65178] \sin w - [3{\cdot}48527] \sin l - [3{\cdot}88985] \cos l \cos (\lambda_\Delta + 37^\circ\ 14'{\cdot}3)$$

For Trevandrum.

Lat. 8° 30′·5 N.; Long. $\begin{cases} 76^\circ\ 59'{\cdot}8 & \text{E. of Greenwich.} \\ 3\ 14{\cdot}5 & \text{W. of Madras.} \end{cases}$

	Madras Mean Time. d h m s	Local Mean Time. h m s
Time of first contact ..	Dec. 11 18 48 37	= 18 35 39
Time of greatest obscuration ..	19 49 30	= 19 36 32
Time of last contact ..	20 58 21	= 20 45 23

	h m s
Duration of the eclipse	2 9 44

Angle from north point, of	First contact	63° 29′ West.
	Last contact	108 56 East.
Angle from the Sun's vertex, of	First contact	14 15 Left.
	Last contact	170 4 Left.
Magnitude of the eclipse (Sun's diameter = 1)		0·9371
Limb of the Sun eclipsed		North.

Formulæ for Reduction to different places near Trevandrum.

First Contact.

$$\text{Cos } w = -0{\cdot}2099 - [0{\cdot}20201] \sin l - [9{\cdot}97990] \cos l \cos (\lambda_\Delta - 120^\circ\ 55'{\cdot}0)$$

$$t = 21^h\ 31^m\ 48^s - [3{\cdot}54223] \sin w - [3{\cdot}34107] \sin l - [3{\cdot}78326] \cos l \cos (\lambda_\Delta + 6^\circ\ 31'{\cdot}2)$$

Greatest Phase.

$$\text{Cos } w = -0{\cdot}0358 - [0{\cdot}19843] \sin l - [9{\cdot}99265] \cos l \cos (\lambda_\Delta - 107^\circ\ 40'{\cdot}8)$$

$$t = 21^h\ 42^m\ 22^s - [3{\cdot}41661] \sin l - [3{\cdot}83136] \cos l \cos (\lambda_\Delta + 20^\circ\ 50'{\cdot}1)$$

$$\text{Magnitude of the eclipse} = 1{\cdot}0173 - (1{\cdot}0173 \cos w)$$

Last Contact.

$$\text{Cos } w = 0{\cdot}2263 - [0{\cdot}19676] \sin l - [9{\cdot}99962] \cos l \cos (\lambda_\Delta - 91^\circ\ 42'{\cdot}0)$$

$$t = 21^h\ 37^m\ 26^s + [3{\cdot}65169] \sin w - [3{\cdot}48752] \sin l - [3{\cdot}88948] \cos l \cos (\lambda_\Delta + 37^\circ\ 10'{\cdot}8)$$

The approximate details of the eclipse for Baicull on the western coast, Ardangi near the east coast, and Trincomalee in Ceylon, all of which will be near the central line, will be as follows:—

For Baicull.

Lat. 12° 24′ N.; Long. { 75° 4′·0 E. of Greenwich. / 5 10·3 W. of Madras.

	Madras Mean Time.	Local Mean Time.
	d h m s	h m s
Time of first contact ..	Dec. 11 18 47 5	= 18 26 23
Beginning of the total phase ..	19 45 51	= 19 25 9
Middle of totality	19 46 55	= 19 26 13
Ending of the total phase ..	19 47 59	= 19 27 17
Time of last contact ..	20 54 13	= 20 33 31
	h m s	
Duration of the Eclipse ..	2 7 8	
Duration of totality ..	0 2 8	
Angle from north point, of First contact	69° West.	
Angle from north point, of Last contact	113 East.	
Angle from the Sun's vertex, of First contact	6 Left.	
Angle from the Sun's vertex, of Last contact	171 Left.	

For Ardangi.

Lat. 10° 11′ N.; Long. { 79° 3′·0 E. of Greenwich. / 1 11·3 W. of Madras.

	Madras Mean time.	Local Mean Time.
	d h m s	h m s
Time of first contact ..	Dec. 11 18 48 7	= 18 43 22
Beginning of the total phase ..	19 48 49	= 19 44 4
Middle of totality ..	19 49 57	= 19 45 12
Ending of the total phase ..	19 51 5	= 19 46 20
Time of last contact ..	21 0 15	= 20 55 30
	h m s	
Duration of the eclipse ..	2 12 8	
Duration of totality ..	0 2 16	
Angle from north point, of { First contact / Last contact	68° West. / 114 East.	
Angle from the Sun's vertex, of { First contact / Last contact	8 Left. / 171 Left.	

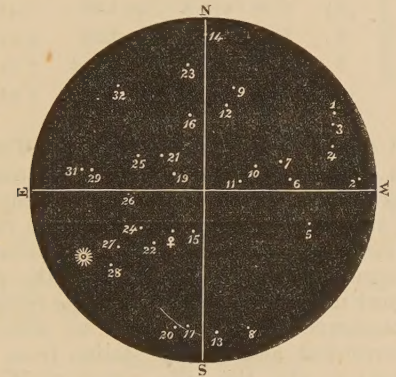
For Trincomalee.

Lat. 8° 33′ N.; Long. { 81° 24′·0 E. of Greenwich. / 1 9·7 E. of Madras.

	Madras Mean Time.	Local Mean Time.
	d h m s	h m s
Time of first contact ..	Dec. 11 18 49 9	= 18 53 48
Beginning of the total phase ..	19 51 19	= 19 55 58
Middle of Totality ..	19 52 16	= 19 56 55
Ending of the total phase ..	19 53 13	= 19 57 52
Time of last contact ..	21 4 23	= 21 9 2
	h m s	
Duration of the eclipse ..	2 15 14	
Duration of totality ..	0 1 54	
Angle from north point, of, { First contact / Last contact	67° West. / 114 East.	
Angle from the Sun's vertex, of { First contact / Last contact	9 Left. / 170 Left.	

I have adhered throughout to the method of Mr. Woolhouse, adopting the positions of the Sun and Moon as given in the *Nautical Almanac*. Subjoined are the approximate positions of bright stars and planets most conspicuous to the naked eye during the time of totality, referred to the zenith of Avenasi.

		Zenith Distance.	Azimuth
		°	°
1	Castor	78	N 59 W
2	Procyon	80	N 86 W
3	Pollux	76	N 63 W
4	Jupiter	71	N 71 W
5	α Hydræ	58	S 72 W
6	Regulus	44	N 84 W
7	γ^1 Leonis	41	N 71 W
8	η Argus	76	S 18 W
9	α Urs. Maj.	56	N 16 W
10	δ Leonis	29	N 66 W
11	β Leonis	19	N 76 W
12	γ Urs. Maj.	45	N 14 W
13	α^1 Crucis	74	S 5 W
14	Polaris	80	0
15	Spica	23	S 13 E
16	η Urs. Maj.	40	N 11 E
17	β Centauri	72	S 8 E
♀	Venus	28	S 39 E
19	Arcturus	20	N 60 E
20	α^2 Centauri	74	S 12 E
21	ε Bootis	29	N 52 E
22	α Libræ	38	S 45 E
23	β Urs. Min.	66	N 8 E
24	β Libræ	39	S 59 E
25	α Cor. Bor.	38	N 62 E
26	α Serpentis	40	S 87 E
27	β Scorpii	54	S 56 E
28	Antares	62	S 52 E
29	α Herculis	61	N 81 E
⊙	Sun	71	S 61 E
31	α Ophiuchi	66	N 80 E
32	γ Draconis	71	N 39 E



To facilitate the independent determination of the longitude of any place of observation, I have calculated such occultations of stars by the Moon as will occur about a week before or after the day of the eclipse. It unfortunately happens, however, that during this time only one bright star lies within the limits of the Moon's path, and so I have been obliged to rest contented with much smaller stars than are usually selected for such a purpose. The computations have been made for Madras and Avenasi, by an approximate method, which usually gives the times within a minute, and the angular points of contact within a degree, of those found by a more refined process. The times at Avenasi will differ but slightly from those for any other spot along the shadow line, in its course across India.

Occultations as seen at Madras.

Date.	Stars.		Mag.	Disappearance. Madras Mean T.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Madras Mean T.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.
				h m	°	°	h m	°	°
Dec. 3	ν Leonis		3½	14 35	128 E	143 Right	16 8	84 W	9 Right
6	XII. 394 Weisse		9	14 13	147 E	136 Right	15 9	92 W	15 Right
14	20114	Oeltezon Argelander's zone.	9	6 41	16 E	50 Right	7 5	44 W	115 Right
14	20133		9	7 1	53 E	16 Right	7 43	80 W	154 Right
14	20138		8½	7 7	109 E	39 Left	7 45	136 W	150 Left
15	21093		8	8 22	83 E	11 Left	9 16	128 W	156 Left
16	21791		8	6 9	36 E	8 Right	7 26	100 W	160 Right
16	21810		7½	6 31	88 E	37 Left	7 36	150 W	148 Left

Occultations as seen at Avenasi.

Date.	Stars.		Mag.						
Dec. 3	ν Leonis		3½	14 32	136 E	137 Right	15 58	89 W	15 Right
6	XII. 394 Weisse		9	14 16	155 E	125 Right	15 5	103 W	24 Right
14	20114	Oeltez n Argelander's zone.	9	6 38	18 E	48 Right	7 7	46 W	117 Right
14	20133		9	6 59	55 E	15 Right	7 43	82 W	157 Right
14	20138		8½	7 6	110 E	40 Left	7 45	138 W	147 Left
15	21093		8	8 21	84 E	12 Left	9 15	132 W	151 Left
16	21791		8	6 2	36 E	8 Right	7 15	100 W	160 Right
16	21810		7½	6 26	87 E	37 Left	7 32	151 W	148 Left

The general circumstances under which the Total Eclipse of Dec. 11th, 1871, will occur, are singularly and unusually favourable, the greater portion of the shadow-path being easily accessible by means of the railway and good public roads; while a well-managed line of telegraph will afford facilities for that most incomparable means of fixing the longitude of the place of observation with regard to Madras. The favourite Sanitarium of the Presidency, Ootacamund, will doubtless be selected by many persons as a convenient and familiar station from which to observe the eclipse; as also the hilly region of Wynaad, in the Malabar district, where numerous European gentlemen reside for the purpose of superintending their coffee-plantations. The lofty peak of Dodabetta, the highest point of the Neilgherries, 8640 feet above sea-level, would agreeably to the often-repeated and enlightened view of Prof. C. Piazzi Smyth, the Astronomer Royal for Scotland, offer a grand opportunity for spectroscopic observations, in an atmosphere of small density and free from all the impurities which abound at lower levels, but unfortunately haze and mist are very prevalent on the hill-ranges in the month of December. The weather is in general fine elsewhere about that time along the shadow-path, but more especially so eastward of the Neilgherry hills than towards the Malabar coast.

Madras,
5th December, 1870.

Erratum in Results of Greenwich Observations of Solar Eclipse of 1860, *July* 18.

(*Communicated by the Astronomer Royal.*)

On examining the reduction of these Observations it was found that, owing to the printing of 1 L for 2 L in the Third Series of Observations, the wrong signs were given to the coefficients of $d\,S$ and $d\,s$; the following corrections are therefore required in the Volume of *Greenwich Observations* for 1860:—

Page 71, Solar Eclipse, Signs of Coefficients of $d\,S$ and $d\,s$ *for* $-$ *read* $+$.

Page 77, Equations given by Transits of Limbs, Signs of Coefficients of $d\,S$ *for* $-$ *read* $+$ and of $d\,s$ *for* $+$ *read* $-$.

Page 78, in the Third Final Equation the Sign of the Coefficient for $d\,S$ *should be* $+$ and for $d\,s$ $-$.

The correct solution of the Equations is as follows:—

$$\begin{aligned} d\,a &= -\ 35''\cdot816 \\ d\,S &= -\ 2\cdot235 \\ d\,s &= -\ 3\cdot350 \\ d\,\delta - d\,\Delta &= -\ 8\cdot349 \end{aligned}$$

Correction to Moon's Tabular Longitude:—

	for	$-\ 36''\cdot94$	*read* $-\ 34''\cdot32$
E. N.P.D.	*for*	$-\ 1\cdot77$	*read* $-\ 1\cdot85$

In the paper by the Astronomer Royal, in vol. xxi. of the *Monthly Notices*, on page 156, line 15,

for "Sun's 1 L & Moon's 1 L"
read "Sun's 2 L & Moon's 2 L"

Page 157, line	3,	*for*	$-\ 38\cdot63$	*read*	$-\ 35\cdot816$
,, ,,	4,	,,	$-\ 8\cdot75$	,,	$-\ 8\cdot349$
,, ,,	5,	,,	$-\ 1\cdot45$	,,	$-\ 2\cdot235$
,, ,,	6,	,,	$-\ 2\cdot97$	,,	$-\ 3\cdot350$
From bottom ,,	4,	,,	$-\ 1\cdot1$	,,	$+\ 1\cdot68$
,, ,,	3,	,,	$-\ 4\cdot0$	,,	$-\ 3\cdot55$
,, ,,	2,	,,	$+\ 0\cdot3$	,,	$-\ 0\cdot54$
,, ,,	1,	,,	$-\ 2\cdot4$	,,	$-\ 2\cdot75$

Observations of the Solar Eclipse of 1870, *Dec.* 21–22, *made at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer Royal.*)

As this eclipse afforded a very favourable opportunity of determining the error of Hansen's Lunar Tables at the period of conjunction, a plan of observations, similar to that arranged for the eclipse of 1860, was prepared by the Astronomer Royal, and carried out as far as the weather permitted.

With the Great Equatoreal four quantities were to be determined, viz.:—

da = Correction to excess of Moon's R.A. over Sun's R.A.
$d\delta - d\Delta$ = „ „ „ N.P.D. „ N.P.D.
dS = „ Sun's Semidiameter
ds = „ Moon's „

for which the following arrangement of observations was made:—

(1) A series of differences of N.P.D. of the Upper and Lower Cusps, showing principally the effect of the correction,

$$ds + dS + da.$$

(2) A series of differences of times of transit of Moon's 2 L. and Sun's 2 L., giving

$$ds - dS + da.$$

(3) A series of differences of N.P.D. of Moon's N.L. and Sun's N.L., giving

$$-ds + dS + (d\delta - d\Delta).$$

(4) A series of differences of N.P.D. of the Right and Left Cusps, giving chiefly the effect of da.

(5) The same as series (3).

(6) A series of differences of times of transit of Sun's 1 L. and Moon's 1 L., giving

$$-ds + dS + da.$$

(7) A series of differences of N.P.D. of the Upper and Lower Cusps, giving

$$ds + dS - da.$$

The first set having been lost through cloud, the remainder furnished five resulting equations, formed by taking the sums of the equations, corresponding to each series of observations, obtained by a comparison of the measured with the tabular quantity as affected by the symbolical corrections given above. These being treated by the method of least squares gave four equations, of which the following is the solution:—

$$\begin{aligned} d\alpha &= -6''.47 \\ d\delta - d\Delta &= +1''.21 \\ d\mathrm{S} &= -1''.68 \\ ds &= -0''.49 \end{aligned}$$

From meridian observations on Dec. 20, 23, 24, 28, 29, the Sun's tabular error was found:—

$$\begin{aligned} \text{In R.A.} &= +0^{s}.11 \\ \text{In N.P.D.} &= +2''.2 \end{aligned}$$

Combining this result with that given above, we obtain as the tabular error of the Moon:—

$$\begin{aligned} \text{In R.A.} &= +0^{s}.54 \\ \text{In N.P.D.} &= +1''.0 \end{aligned}$$

The effect of these corrections on the choice of stations for observing the totality appears to be very small. The central line would be shifted nearly 5 miles further south, and the breadth of the shadow increased by about double that amount, whilst the time of first contact would be accelerated and of last contact retarded by about 10^{s}.

The altazimuth observations give error of tabular altazimuth:—

$$\begin{aligned} \text{Of Moon's 2 L.} &= -11''.00 \text{ from } 6 \text{ Obs.} \\ \text{,,} \quad 1 \text{ L.} &= -3''.83 \text{ ,, } 12 \text{ ,,} \end{aligned}$$

Whence error of Tab. Geoc. Semidiam. $= +3''.48$.

Applying this as a correction to the semidiameter used in the reduction of the observations of Z.D. of Moon's U.L. we find tabular error of Moon:—

$$\begin{aligned} \text{In R.A.} &= +0^{s}.54 \\ \text{In N.P.D.} &= +2''.54 \end{aligned}$$

As from altazimuth observations of the *bright* Moon the error of semidiameter in azimuth $= -0''.5$, the eclipse observations give for the sum of irradiations of Sun and Moon with the altazimuth $4''.0$ for an object-glass of $3\frac{3}{4}$-inches.

With the Great Equatoreal (aperture $12\frac{3}{4}$-inches) the value appears to be about $0''.5$.

The Solar Eclipse, Dec. 22, 1870. By the Rev. S. J. Perry.

(*Communicated by W. H. H. Hudson, Esq.*)

A mere glance at the published results of the late Eclipse Expeditions will be sufficient to convince any one, who is at all conversant with the subject, of the great advance that has just been made in our knowledge of solar physics. That so much should have been accomplished, when the obstacles to success

seemed to meet the observers at every turn, is a matter of no little surprise, and the value of the observations already published is an earnest of what we are to expect from a careful discussion and arrangement of the collective results.

No one will doubt but that much good work has been done during the two short minutes of totality by the polariscope and spectroscope, by the telescope and eye observations, and by photography, and it would be a matter of no small difficulty to determine at present the relative merits of these several aids to our observers. We shall therefore form a fair idea of what has been effected by the various modes of observation, if we pass in rapid review the triumphs of a single one. Let us take spectroscopy, for instance.

Passing over the accurate determination of the time of first contact, of which a warning of 15^s was given by Prof. Young, from the observed gradual extinction of the bright lines of the chromosphere by the Moon's dark limb, we come to the observations that have a more direct bearing on solar physics.

If we start from the photosphere in an outward journey, we find at the outset that the observations of Prof. Young and Mr. Pye of London have satisfactorily closed a discussion which has occupied so many pages of the *Comptes Rendus*, the *Philosophical Magazine*, and other publications during the last twelve months, as to the existence of a thin absorption shell dividing the photosphere from the chromosphere. What had so far been invisible to our English spectroscopists, but what Secchi, favoured by a clear Roman atmosphere, had seen as a continuous spectrum, burst forth during the eclipse as an innumerable mass of bright lines apparently identical in position with the dark absorption lines of the solar spectrum. This glorious sight lasted but for one or two seconds, being visible only when the stronger light of the photosphere was eclipsed, and eclipsed itself in turn by the dark Moon as soon as visible. This thin shell of vapours, scarce 1000 miles in thickness, possesses an importance far greater than its relative extent alone would justify, if we may look upon it as the seat of that selective absorption which gives existence to the dark Fraunhofer lines.

Continuing our outward journey we come next to the chromosphere, whose constitution and wondrous forms, and still more wondrous motions, are now a matter for daily study and observation, and therefore possess less of interest for the observer than those other spherical shells of vapour, which can only be examined during the fleeting moments of totality. The addition of some new faint line, or of the exact form of a few solar prominences, could scarcely add appreciably to the knowledge acquired by the labours of Lockyer, Young, Respighi, and others, and would not repay the loss of time so valuable for other researches.

But the outer layer of cooler hydrogen, whose tale has just been told by the spectroscope of Mr. Abbay, is more worthy of present attention. The bright lines 1474 and F were seen

together; F less brilliant than 1474. Mr. Pye, by whom a similar observation was made of 1474, C, D_3, and F, estimated the relative brightness of the four lines, and found them to vary as the numbers 100, 85, 55, and 30. The observations of Denza and Carpmael, who both saw two lines in the corona, and those of Harkness, Barton, &c., will probably be found to confirm the above; and may, moreover, give the definite portion of the corona under observation, which Abbay and Pye could not do from the nature of their instruments.

Hydrogen, therefore, which gives a spectrum so much more bright than the green line 1474 when seen in chromosphere, must in the observations under discussion be far less heated, and becoming thus unable to send us in any strength its crimson light, shines mainly with a borrowed solar light. Hence the strong radial polarization; hence the silvery white of the leucosphere, or ring-formed inner corona, which I suppose must consist in great part of the cooler hydrogen, mixed of course with the green vapour of the line 1474. Burton's observation of the extension of the hydrogen lines also tends to strengthen this position, and to establish the reality of the cooler hydrogen envelope.

The absence of the dark Fraunhofer lines should be of little weight, considering the faintness of the spectrum.

But the argument from the varying brilliancy of the lines appears somewhat weakened by the observation of Capt. Maclear, who found the hydrogen lines everywhere,—in prominences, on corona, on dark Moon,—their varying brightness depending not on their internal heat, but on the mode of their reaching us, either as direct or dispersed rays. This strong dispersion of the chromospheric lines by cloud and atmosphere also renders any accurate determination of the limits of the several solar envelopes, by aid of the spectroscope, a matter of the greatest difficulty.

But whatever the exact extent of the inner shells of vapour, of the absorbing envelope, or chromosphere, or leucosphere, we come at last to a hollow sphere of vapour lighter than hydrogen, whose spectrum is the bright green 1474, whose internal diameter we may perhaps roughly guess at, but which outwardly stretches forth into space, probably far beyond any limits we are likely accurately to measure. Prof. Young followed this line, as it gradually diminished in brightness, from the photosphere to a distance of 16′ from the Moon's limb, whilst Winlock traced it to 20′; but the bright lines seen on the dark Moon tell us that the observed extent may in part be due to the dispersion from the atmosphere. The observations of Young and Winlock are confirmed by those of Burton, Harkness, Pye, Abbay, and others, thus leaving no room for us to doubt the existence of this vast sphere of vapours, which will probably enter largely into all future theories of the ether of space.

On the Colour of the Moon during the late Eclipse.

By Richard A. Proctor, B.A. (Cambridge).

During the late eclipse the Moon's disk appeared green. It was compared by one observer to dark green velvet. At first sight it might appear as though a full explanation of this was supplied by the fact that the air towards the Moon's body was illuminated by the corona, the principal line in whose spectrum is green. But as the corona itself did not appear green, we must suppose that the chief portion of the corona's light was in reality that which gave the faint continuous spectrum; and this must needs be the case with the coronal light reflected by our own atmosphere. It may be assumed, therefore, that the coronal (reflected) light received from the direction of the Moon's body could not have been appreciably green; and the observed greenness of the Moon's disk must be otherwise explained.

It seems to me that a sufficient explanation is to be found in the nature of the light received by the Moon from the Earth during the Eclipse. This light as respects quantity must have been considerable,— in fact (for equal surfaces) some thirteen times that with which the full Moon illuminates the Earth.* Its colour must have been green, I think; because the proportion of land and sea surface in the terrestrial disk, as seen from the Moon, was such that calling the ocean blue-green and the land brownish (on the average), the resulting mixed colour would be a deep green. (In the *Quarterly Journal of Science*, for October last, I have shown the exact orthographic presentation of the Earth's disk towards the Moon near the epoch of totality.)

Now during the Eclipse of 1860 land and sea were turned towards the Moon in different proportion. The eclipse occurred in summer, so that the northern or land portion of the Earth was less foreshortened, and furthermore the eclipse occurred at about three in the afternoon, by which hour the two Americas were well advanced upon the Earth's disk as seen from the Moon. One would, therefore, expect that the Moon's disk on that occasion should have presented a brown hue. And accordingly we find Mr. De La Rue so describing it.

It would appear probable, therefore, that our Earth, as seen from distant stations, as *Venus* or *Mercury*, is usually a green planet, but sometimes dun or fawn-coloured. Also her rotation may probably be recognised without telescopic aid, simply by her colour-changes.†

* The Moon's shadow on the Earth would have the effect of diminishing this light by the same amount as if, instead of umbra and penumbra, there were a black shadow whose foreshortened aspect seen from the Moon equalled the Moon's disk as seen by ourselves.

† When this paper was read, another explanation of the Moon's colour was suggested; and, further, the reality of the colour was called in question. But I would note that the explanation I here offer, whether sufficient or not, undoubtedly refers to a *vera causa*. We know how bright a distant hill illuminated by the full Moon appears: now the Moon's surface is certainly illuminated thirteen times more brightly by the "full" Earth, during total eclipse. Nor can it well be questioned that the earth-light must be at times strongly coloured.

Note on the Corona. By Richard A. Proctor, B.A.

A year since, I had occasion to address the Society on the subject of the corona. I then pointed out that no direct sunlight can illuminate the part of our atmosphere which lies towards and around the Moon's place; and the purpose with which I wrote was fulfilled when the views I dealt with were withdrawn from public attention. At that time it seemed to me, on the one hand, very unsafe to theorize about the actual constitution of the corona; but, on the other hand, it seemed demonstrable that the corona is a solar appendage. At present we are, I think, more favourably circumstanced; more especially on account of those photographic successes with which astronomers—as well workers as thinkers—have such good reason to be satisfied.

I propose to place before the April meeting of the Society certain views to which, as I think, the recent observations seem to point. At present, however, my object is merely to note what I take to be by far the most important contribution to our knowledge respecting the corona. I cannot regard the differentiation of the corona into two portions* as an acquisition, simply because for more than a century and a half the distinction had been recognised by astronomers. Nor can I attach any signal importance to the proof afforded by recent observations that the corona has a great extension from the Sun; nor to the confirmation of the long-disputed American observations; because both these points were in effect established before the eclipse took place.

The great result of the recent eclipse observations will be found, unless I mistake, to lie in the association now shown to exist between the configuration of the inner and brighter portion of the corona and its outer and more strikingly radiated portion. This is shown unmistakably by a comparison of the accounts of Lieut. Brown and Prof. Watson with the photographs of Mr. Willard and Mr. Brothers. It was indeed strikingly evidenced during the eclipse of 1869, but not absolutely demonstrated. It seems to me a fact of the utmost importance and significance; more especially when combined with the seemingly established relation between the regions of greatest prominence-disturbance and the expansions of the inner part of the corona, and with that other relation which associates the spot-zones with the larger and more active prominences.

It might seem at first sight that the long radiations opposite the bright parts of the inner corona could be explained as due to the illumination of our own atmosphere in corresponding directions. But the simple consideration of the way in which our atmosphere is illuminated by the corona will show that no radia-

* I would submit that the word "defined" applied in the Report of the Council to the outline of the inner part of the corona, requires to be modified or explained; for undoubtedly the inner corona was not bounded by what is usually understood as a defined outline. The border of this part of the corona showed a rapid but not sudden degradation of brilliancy, having a perfectly soft outline nowhere sharply defined.

tions extending outwards could make their appearance without corresponding expansion on either side, and a yet more marked extension inwards over the Moon's disk.* The uniformity of the light over the Moon's disk, its faintness, and especially its observed inferiority to that received 15′ from the Moon's limb, would suffice to disprove the imagined explanation, which is also, however, opposed to the simplest optical considerations.

I conceive we have now clear evidence of a form of action—but whether eruptive, electrical, or simply repulsive, is not as yet obvious—exerted outwards to enormous distances by the Sun, and with maximum energy over the spot-zones, but local, variable, and probably intermittent.

The annexed woodcut of the spots on the Sun about the time of the Eclipse of December last, should have accompanied Lieut. A. B. Brown's account of the Eclipse as given in the January number of the *Monthly Notices*.

Sun-Spots, Dec. 18, 1870 (12.15 P.M.)

* It was with much pleasure that I heard Mr. Brothers read at the last meeting a letter from Dr. Balfour Stewart, in which views were expressed precisely similar to those above enunciated. In the same letter Dr. Stewart pointed out (as I had shown in the *Monthly Notices* for March, 1870), that though our atmosphere towards the Moon's place is undoubtedly illuminated by light from the prominences, sierra and inner corona, yet that the quantity of light received in this way can bear no higher proportion to the actual light of the corona and prominences than the atmospheric glare in full sunlight bears to such sunlight. It has been this argument — absolutely demonstrative, despite its extreme simplicity—which has caused me for many months past to feel complete certainty respecting the general nature of the corona.

Report of Professor W. G. Adams, on Observations of the Eclipse of December 22nd, 1870, made at Augusta, in Sicily.

King's College, London, February, 1871.

Before the final arrangements were made by the Organising Committee I was asked to join the English Eclipse Expedition. Not being able to leave with the other Members of either Expedition, on account of my lectures at King's College, I followed the Sicilian party on the evening of Friday, the 9th of December, and joined them on the morning of Wednesday, the 14th, in Naples. The *Psyche* arrived during the day, and we went on board, and she steamed out of harbour at four o'clock. It was a peaceful afternoon, with no wind and a perfectly calm sea, and the view of the bay, with Naples in the sunshine and Vesuvius sending out light puffs of steam and smoke, was very beautiful. The sea kept perfectly calm through the night, and on the morning of the 15th, after passing Messina, a meeting was held and observers were stationed. The instruments were brought on deck, and we were enjoying the scenery of the coast and of Etna when the unfortunate wreck of the *Psyche* cast a gloom over our Expedition and entirely altered our arrangements. It was intended that Syracuse should be the head-quarters, but now Mr. Lockyer took up his station at Catania. Professor Roscoe took charge of a party to observe on the slopes of Etna, and I was asked to take charge of the Augusta Expedition. The other observers for Augusta were —

Mr. Brett, with a reflector for sketching the corona;

Mr. Burton, with a spectroscope;

Mr. Clifford, Mr. Ranyard } for observations on polarization;

Mr. Samuelson, for general observations.

Colonel Porter also volunteered to sketch the corona, and some officers of the Royal Engineers were expected from Malta for the day of the eclipse.

Mr. Brett was asked to proceed at once to Augusta and arrange with Colonel Porter about our camp and observatory.

With such an excellent practising ground as the terraces and gardens of the Benedictine Monastery, it was thought better that the Etna and Augusta observers should stay at Catania until Monday, the 19th, and practise with their instruments. As there had been no opportunity for testing the instruments, this comparison was very important, especially for all those who were to observe for polarization; some of whom had never seen their instruments. All the observers for polarization except Mr. Ranyard remained, and arranged the sets of observations to be made by each observer, so that if the weather was favourable, the determination of the polarization of the corona should be complete. We found this previous practice of very great value, and before we parted Mr. Griffiths and I made comparative observations with our polarimeters with very satisfactory results. Turning to

the same points of clouds and buildings, we determined the plane of polarization, and measured the degree of polarization in the light at the rate of from 10 to 15 seconds for each point of observation; and in some cases our readings both for plane and degree of polarization were absolutely identical.

Description of Instruments.

To my own telescope ($2\frac{1}{4}$-inch object-glass), an altitude and azimuth instrument, I had fitted at the principal focus of the erecting eye-piece a plate of right-handed and left-handed quartz, a small Nicol's prism being placed at the stop. I had also requested Mr. Ladd to fit to my telescope a polarimeter eye-piece, consisting of a Savart's polariscope (a plate of quartz cut obliquely, and a Nicol's prism), with four plates of glass for a depolariser. Just before I left for Sicily, Professor Stokes expressed a wish that I would use the double-rotating quartz to test the observations made by Prazmowski at the Eclipse of 1860, and recommended that Mr. Ranyard and I should observe at different places along the central line. Accordingly, it was arranged with Mr. Ranyard at Catania, that on the morning of the 22nd he and another of our party should drive some miles up from Augusta, in the direction of the hills of Carlentini to observe the eclipse.

On comparing my two eye-pieces, I found that when the polarization was not strong, the double-rotating quartz eye-piece was not nearly so delicate as the polarimeter eye-piece for detecting the plane of polarization, but gave a clearer view of the point of observation. In addition to these, Mr. Becker had fitted up for me another polarimeter to be used without a telescope, consisting of four glass plates, a very delicate natural quartz crystal, giving right-handed and left-handed rotation, and a Nicol's prism. When the planes of polarization of the polariser and analyser are coincident, the crystal gives a central white band with a tinge of red on the outside of it; then a dark purple band, gradually shading outward through blue, green, and yellow, to the pink field covering the remainder of the crystal. On turning the analyser the bands move parallel to themselves across the field, each colour occupying the position of its complementary colour, when the analyser has been turned through a right-angle, the tint on the outside of the field being a bluish green. The crystal was placed behind the glass plates and the Nicol's prism at the other end of a telescopic tube. By drawing out the tube to about one foot in length the field of view could be reduced to about six diameters of the Moon. This tube was supported and could turn in another tube which was attached to a wooden stand which allowed of motion in altitude and azimuth. By position circles on the fixed tube and on the box containing the glass plates, the plane and degree of polarization could respectively be determined. The existence of the dark bands in this crystal made it so delicate that, with faint light

when there was not a trace of colour to be seen, I could detect polarization and approximately determine the plane, and on a dark day I could determine the plane and the degree of polarization on the clouds when there was not more than one per cent of polarization. With this instrument I had intended to make observations on the sky before the eclipse, and during totality to observe the streamers and the body of the Moon if time permitted, in addition to making two or three observations on the Corona with the Prazmowski arrangement. I had hoped to have an officer of the Royal Engineers to assist me and confirm my observations, and should have taught him how to use the instrument for the observations during totality. I had intended to register the observations by drawing lines against the index as a ruler with a pencil of a different colour for each observation, writing the number of the observation with the same pencil. I also took out with me an extra telescope, the eye-piece being fitted with a plate made up of two wedges of quartz with their axes at right-angles to one another and to the axis of the tube. Mr. Pierce, jun., of the American party, was at Catania, and as his spectroscope had not arrived, the eye-piece of this telescope was lent to him to fit to his own small telescope, Mr. Ranyard having taken its proper tube and object-glass to Augusta.

On Monday, the 19th, Mr. Clifford and I left Catania in a boat to go to Augusta. In consequence of a breeze from the sea we did not reach Capo San Croce until eight o'clock, and after turning it we had a strong land breeze against us from the west. Twice during the evening, about half-past six and again about seven o'clock, we saw a brilliant display of the aurora. It was far more brilliant than the remarkable aurora which I had seen in October, and more beautiful than any I had ever seen. First, pink streamers shot up perpendicularly to the eastern horizon, passing across the planet *Jupiter*. I judged that these must have been in or very near to the ecliptic. These were followed by other streamers shooting up from the north and north-east until the sky became covered with a pinkish mauve colour. Round the eastern and northern horizon there was a faint hazy grey light as if a thick mist were coming on, but which was seen to be connected with the aurora by its fitfulness. The zodiacal light was seen in the western sky near the ecliptic as a hazy white light. As the evening grew darker we saw the strong phosphorescence of the sea. There was a bright glow on the drops thrown up by the oar as it struck the water, and the forms of the eddies caused by the bending of the oar were distinct and brilliantly illuminated.

Through the kindness of Prof. Cavalieri Cacciatore of the Palermo Observatory, and Father Denza, who made comparisons for time, I was able to obtain the latitude and longitude, as well as the local times of the different phases of the eclipse according to their calculations.

Latitude of Fort Augusta	37° 14′ 0″·6 N.
Longitude (in time)	1h 0m 52s·2 E.
Difference of longitude between Augusta and Palermo	7m 26s·6

	Local Times.	
	Italian.	Hind.
	h m s	h m s
First contact	0 39 17	
Beginning of totality ..	2 1 56·7	2 1 51·8
Middle..	2 2 52·1	2 2 46
End of totality	2 3 47·5	2 3 40·3
End of eclipse	3 21 21	
Duration of totality ..	1 50·8	1 48·5

The following observations were made with my Aneroid Barometer registering from 31 inches to 15 inches, and which had been regularly compared with a standard barometer, and found to indicate pressures very accurately.

Day.	Hour.	Pressure.	Remarks.
Dec. 20	9 A.M.	29·87	
	12 NOON	29·82	
	3 P.M.	29·82	
	6 P.M.	29·77	
21	7 A.M.	29·68	
	12 NOON	29·65	
	8 P.M.	29·50	Report of bad weather in Italy and Sicily; wind westerly; sirocco expected.
	11 P.M.	29·45	
22	7 A.M.	29·28	Dec. 22, 2 A.M. Sirocco from the west; very heavy rain; frequent thunder and lightning. 6 A.M. No rain; little wind; lightning in eastern horizon and in heavy stratus cloud to the south-east. 7 A.M. Rain and heavy clouds. 7 15 A.M. Wind rising and becoming violent; clouds in patches.
	11 45 A.M.	29·37	
	12 10 P.M.	29·32	Sky of a watery light blue.
	12 40 P.M.	29·28	Time of first contact.
	3 P.M.	29·30	
	4 40 P.M.	29·30	Wind again becoming violent.
	6 P.M.	29·35	Very high wind.
23	8 30 A.M.	29·44	Bright morning, followed by a fine day.

My barometer was compared with Mr. Burton's smaller aneroid, which showed greater variations than mine, but generally in the same direction.

The five divisons of our observatory were occupied in order by:—

(1) Mr. Brett.
(2) Mr. Burton.
(3) Colonel Porter.
(4) Mr. Clifford.
(5) Myself.

Each observer had one of the Sappers to assist him in preparing his instruments and in recording any notes which it might be necessary to make during totality. Where they were required, tables formed by driving piles into the ground and nailing planks on them were erected for our telescopes.

On the 21st we were able to get our instruments into position, and the Sappers showed their skill in repairing parts of instruments which were out of order.

On the 21st, at 2 P.M., the hour of totality, I fixed my telescope with one foot raised above the level of the table, so that when the telescope was pointed to the Sun, the single motion of rotation about the pillar of the telescope (*i.e.* the motion for change of azimuth), would keep the Sun in the field of view, by making the telescope describe a tangent to the Sun's path. I found it necessary to tilt the pillar of the telescope through an angle of 15° for this purpose.

I considered that besides the convenience of having only one motion, there would be an advantage in referring my observations for polarization to known diameters other than the vertical and horizontal diameters.

The black line shows the position of the line of division of my crystal in the observations which I had planned. By moving my telescope in azimuth in one direction or the other, I passed into my second or third positions, passing through the highest point or the lowest point of the Moon's limb respectively.

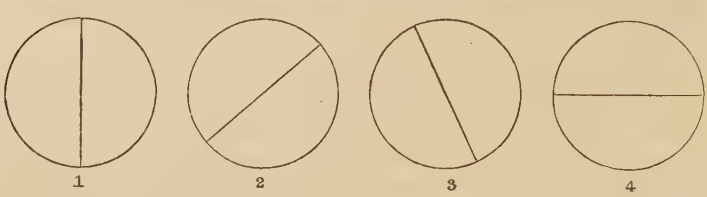
The constants of my telescope are as follows:—

Aperture of object-glass	2¼ inches.
Focal length	31 inches.
Diameter of field	About 50′.
Magnifying power	25.

so that the Moon's apparent diameter was about two-thirds of the diameter of the field. The Nicol's prism was so placed that for a beam of polarised light the two sides of the crystal were of the same pink tint in the centre when the index was at zero, the line of division of the crystal being then in the plane of polarization. On turning the eye-piece, the light on the right changes towards the more refrangible end of the spectrum, and the light on the left becomes red, then purple, and blue, until when it is turned through a right angle both sides at the centre are of the same uniform green tint. Turning from the first

position in the opposite direction, the changes take place in the opposite direction.

With Prazmowski's arrangement, I had to bring the Sun into the centre of the field, and to observe first the tint on the two sides at the junction where the line of division of the two quartz plates cuts the limb, then to observe and note the changes of colour round the limb of the Moon on both sides. Then to pass to my second position, and to make the same series of observations, then to pass to my third position, and again observe for each point in the same way. If time remained, after these



observations had been satisfactorily made,—as I had no one to assist me who could make the observations,—I should have used my delicate polarimeter, which was on its stand close to the telescope, and already directed on the Moon, to determine the plane and degree of polarization of the streamers. It was arranged that about two minutes before totality one of the Sappers should give the time at intervals of ten seconds, and that at the last minute before totality he should begin to count continuously and give every five seconds until after totality.

Large thick clouds were flying from the west, and frequently obscuring the Sun and rapidly passing away. When the Sun was about half eclipsed, there was rather a sudden change in the light and a sudden chill was felt in our observatory. About three minutes before totality there were brilliant and very remarkable patches of red and yellow light on a cloud to the right and rather below the Sun. This cloud passed away, and the Sun was quite clear. The time of totality was now very near, and a cloud from the west was threatening to blight our hopes; the band of sunlight was getting exceedingly thin and seemed to be breaking up into sections, when at the very instant the dense cloud came over the Moon and shut out the whole, so that it was doubtful whether the Moon or the clouds first eclipsed the Sun. For a full minute I could detect nothing of the Moon's disk, but moved my telescope very gradually, then the cloud became thinner, and I found the Moon still in the centre of the field. At the top and bottom I saw the dark limb, but no light outside it at these my first points of observation. To the north-east I saw light of the corona or prominences covering some 20° of the limb, and also a fainter light on the western limb of the Moon. I could not detect any colour or any difference of colour denoting polarization on the two plates of my bi-quartz. The Moon was

again obscured entirely, but after a few seconds I again detected light of the corona near the point of emergence, and placed the line of division of my bi-quartz radial to the Moon, having the light in the centre of the field, but I could detect no trace of colour on the two parts of the crystal. The view then became continuous, and the totality was over.

I had found in my previous trials that for faint polarization the bi-quartz was not nearly so delicate as the quartz wedge or the Savart's bands, and these observations show that the polarization, either of the cloud or the corona, was so slight, that it was beyond the power of the bi-quartz crystal to detect it.

I had a very strong impression left on my mind that during totality, the light, which was of greater intensity than I had expected, was different from ordinary white light, and from many experiments I am strongly of opinion that bands rather than colour should be trusted to detect delicate polarization.

Mr. Clifford observed light polarized on the cloud to the right and left and over the Moon, in a horizontal plane through the Moon's centre, and found the plane of polarization inclined at from 15° to 20° to the vertical. At his last observation on the Moon, when it was visible, the plane of polarization was vertical.

Mr. Clifford also saw the corona near the point of emergence about the end of totality.

It will be seen from Mr. Clifford's observations that the plane of polarization by the cloud was very nearly parallel to the line of division of my crystal, *i.e.* nearly at right angles to the motion of the Sun.

Mr. Burton indicated the positions of some of the most remarkable prominences during the morning of the 22nd, and just before totality saw several lines in the spectrum (between D and E) in the chromosphere. At the beginning of totality, with his slit tangential and as near as possible to the east limb, a bright line was distinctly seen in the spectrum, very near E, and a little less refrangible. The line was less defined than the hydrogen lines of the prominences. On account of cloud, this was the only observation of the spectrum which Mr. Burton was able to make. No dark lines were seen. I examined the spectrum with the instrument after the eclipse was over, and found that with the width of the slit used the definition of the dark lines was exceedingly good. Mr. Burton had also intended to observe in order the west, north, and south points. Mr. Burton saw the corona on west side at the end of totality for about two seconds with the naked eye. He says, "The colour was *silvery white* fading *gradually* in brilliancy outward. I am not certain whether the outer boundary was definite or not, I incline to the latter opinion."

Table to Determine the Degree of Polarization of Light refracted through Four Parallel Plates. By Prof. W. G. Adams.

If $\frac{p}{n+p}$ represent the proportion of polarized light in the refracted beam, then, employing the formulæ given in the *Philosophical Magazine* for March, we have

$$\frac{n+p}{p} = \frac{\frac{1}{\sin^2(\varphi - \varphi_1)} + \frac{7}{\sin^2(\varphi + \varphi_1)} - 4}{4}$$

where φ and φ_1 are the angles of incidence and refraction respectively.

For $\mu = 1{\cdot}5$ (crown glass), Angle of complete polarization 56° 18′ 36″
For $\mu = 1{\cdot}513$ Angle of complete polarization 56° 32′

From the results for these two values of μ the values for $\mu = 1{\cdot}54$ are deduced, and for any value of μ the degree of polarized light may readily be calculated from the formula. The values as given in the Paper referred to, are,—

φ	10°	15°	20°	21° 30′	25°	30°	35°	40°
$\frac{p}{n+p} =$	·0107	·02443	·04430	·05683	·07111	·10498	·14745	·19845
For $\mu = 1{\cdot}513$								
$\frac{p}{n+p} =$	·01103	·02504	·04540	(·05813)	·07267	·1076	·1509	·2029
Probable values for $\mu = 1{\cdot}54$								
$\frac{p}{n+p} =$	·0116	·0263	·0476	..	·076	·113	·158	·212

φ	45	50°	55°	56° 18′ 36″	60°	65°	70°	72°
$\frac{p}{n+p} =$	·25786	·32383	·39231	·40984	·4560	·50530	·5309	·53305
For $\mu = 1{\cdot}513$				(For 56°32′)				
$\frac{p}{n+p} =$	·2635	·3305	·3999	·4204	·4642	·5139	·5394	(·5416)
Probably values for $\mu = 1{\cdot}54$								
$\frac{p}{n+p} =$	·275	·344	·415	..	·481	·531	·556	

From the table, for the values of $\frac{p}{n+p}$ we see that for four plates the proportion of polarized light in the beam which passes through the plate still goes on increasing when the incidence becomes greater than the angle for complete polarization, and that at about 72° it attains its greatest value, when there is about 53 per cent of the light polarized.

I have also formed a table for $\mu = 1{\cdot}513$, of which the results are given; and from these we can derive close approximate values for the proportions of polarized light for values of μ not differing much from these values.

The probable values for $\mu = 1{\cdot}54$ are given in the table.

If we employ the four plates as a depolarizer to determine the proportion of polarized light in the incident beam by reducing the light to its ordinary unpolarized state, then the proportion of polarized light in the incident beam will be given, for any angle of complete depolarization, by the value of $\frac{p}{n+p}$ for that angle.

Extract from a Report of the Eclipse Expedition of 1870, *at Augusta, Sicily.* By John Brett, Esq.

During the violent squalls of the night of the 21st, some heavy rain fell, and the morning of the Eclipse dawned badly. A sketch was made of the sunrise, which was red and threatening; but after daylight the sky partially cleared, and all the morning we remained in suspense, hoping perhaps, but dreading certainly.

Two members of our party were now detailed to Villa'smunda, and a Sapper, named Buchanan, was taught by Professor W. G. Adams to call the time in the observatory.

As the day advanced the sky rather improved, and the Sun's limb was fairly steady. The apparatus in my compartment of the observatory consisted chiefly of a reflecting telescope of silvered glass, $8\frac{1}{2}$ inches aperture and 7 feet focus, made by Mr. Browning, with an altitude and azimuth mounting of extraordinary steadiness. The defining power of this instrument is of first-rate excellence; and one side of the tube being entirely removed, no air-currents are generated in it by the Sun's heat, nor are any musical vibrations set up by the wind. Affixed close to the eye-tube was a card with a black disk on it for the purposes of drawing, and another for writing notes. The observations were commenced with a solar eye-piece, consisting of a first reflection prism, to which were applied alternately a Kellner with a field of 45′, power 75; a Kellner with field of 35′, power 100; and one of Mr. Browning's exquisite achromatic doublets, power 200; the two former supplied with dark glass, the latter with a sliding wedge. The first contact was beautifully seen and the exact time noted, the limb being fairly steady and the instrument perfectly so. Ten minutes later I suspected traces of a weak halo round the Sun, and at twenty minutes after first contact this had become more pronounced, presenting a tolerably well-defined boundary at a distance of about 2′ from the limb. I begged Mr. Burton, my next neighbour in the observatory, to bring his experienced eye to bear upon it, which he did. At the same time he called my attention to a tinge of redness towards the Sun's limb (on the disk), of the

colour of iron rust, which remained permanent. The halo was of a pallid grey colour. It was equally distinct under either of the eye-pieces mentioned above, and at a later stage of the eclipse the Moon's disk was decidedly visible beyond that of the Sun for about 2′ projected with a clear edge upon the halo. I could come to no other conclusion than that this was really the corona; yet it seemed to me a suspicious circumstance that it did not grow much more vivid as the eclipse approached totality. The Moon's limb was beautifully defined on the Sun's disk, and *considerably sharper* than the limb of the Sun. The contrast of the two limbs in this respect was very remarkable. There was, however, a weak illumination encroaching upon the Moon, of a greyish tint, but it faded away from the limb inwards imperceptibly, and was nowhere nearly so intense as the halo or corona of the Sun. Occasionally some clouds passed over, but nothing in any degree disturbed or interfered with the halo.

At Mr. Burton's suggestion I very carefully observed the eclipse of two large spots with power 200 for distortion, but found no trace of any, definition being then good. After this period I directed my attention chiefly to the cusps; but, although they were blunted more or less, nothing remarkable occurred until five or six minutes before the total phase, except that I satisfied myself that the Moon's disk was only visible off that of the Sun, as far as the halo or corona extended. The wind which had been strong all day now increased considerably; some of the more violent gusts being very inconvenient in the observatory; and for instruments not very steadily mounted would have been a serious hindrance. There were plenty of clouds about, but not threatening total obscuration, and hopes of a good observation were entertained freely. The silence within the observatory was contrasted in a singular manner by the increasing roar and howling of the populace without, who seemed to have assembled in a dense multitude about the further borders of the glacis in a state of great excitement. The time seemed immensely long. I was keeping my attention on the cusps, and had already seen one or two beads nipped off by the Moon's mountains, and the time had come to prepare for the total phase. About five minutes before that period I went to the side of the observatory and looked over at the landscape for a few seconds, but beyond a general gloom over all, of a leaden lurid hue such as I expected, I saw nothing particularly remarkable.* The clouds were getting worse, and the approaching shadow was not visible on the hills.

I returned to the telescope without delay, removed the solar eye-piece and introduced the Kellner, power 100, with dark glass,

* I believe that the wonderful character of the terrestrial appearances recorded during eclipses is to a great extent the measure of the observer's ignorance of ordinary cloud phenomena. Such appearances (to judge from my own experience) would hardly strike a landscape-painter as very abnormal; but the truth is, that very few persons besides artists have ever paid enough attention to clouds and their effects upon landscape scenery to enable them to answer the most elementary questions respecting them.

to take a last look at the cusps before introducing the large field eye-piece with which I proposed to examine the corona. I now beheld a beautiful sight: a delicate and exquisitely defined little ray or cone of light emanating from the south cusp in a direction tangential to the Moon's limb.

Its length was not more than 3′; possibly something less. Its light was less intense than that of the cusp, but as beautifully defined as anything I ever saw in my life. Its termination at the weak end or base of the cone was clearly visible and not diffused indefinitely, and the angle at the apex was small, not more than 5°.

In my drawing of this phenomenon I have rather exaggerated the angle and also the diffuseness of the base, in order to show its character, for the refinement of drawing necessary to represent accurately so delicate an image is forbidden by the coarseness of the materials employed. Having examined this for a few seconds, I brought the north cusp into the field and found a similar ray there, but somewhat smaller. The cloud over the Sun now became so dense as to impede vision seriously, and cause the most profound anxiety. The beads were being nipped off the cusp in rapid succession, and presently the whole rim broke up instantly into fragments of various lengths, and disappeared, and left utter darkness. The dark glass (which I held in my hand) was discarded, but not a trace of anything was visible. I quickly pulled out the eye-piece and replaced it with the lowest power, for the agonising thought occurred to me that the object would presently be out of the field and lost beyond hope; for my finders could do nothing towards penetrating the cloud. I quickly slid in the large field eye-tube but still saw nothing. It might now, I thought, have passed even out of this field, but I dared not move the instrument. The counting of seconds by the Sapper had already advanced to a frightful number, and these were periods of misery never to be forgotten.

Near at hand I had set up a small but beautiful achromatic telescope to supplement my large instrument, fitted with a terrestrial eye-piece that gave a field of a degree and a half and power of 20, hoping by it to be able to take in the streamers (if there were any) at one view. I now turned to that; when presently the prominences burst all at once into view; and I immediately went back to the reflector and happily got a magnificent sight of them; but I was astonished and disappointed at not finding any distinct boundary to the corona, nor any hint whatever of streamers. The whole limb was literally crowded with prominences, varying in colour from white and yellow to pink and nearly crimson. One crooked flame-coloured one was particularly conspicuous.

The appearance on the whole was far more like terrestrial conflagration than I expected.* One respect in which this

* Especially the combustion of wood in a baker's oven when nearly exhausted.

resemblance seemed to me obvious was the proportion both in quantity and luminousness which the flames bore to the haze of shapeless vapour in which they were mixed up. This haze was so like what one sees in a terrestrial conflagration that the idea never would have occurred to me that it was self-luminous. The light that showed no defined form was not a clear flat halo, but suggested the uncertain turmoil of the results of combustion in a furnace.

Some of the tongues or prominences were extremely vivid, but others were much mixed up with the general light surrounding the limb. There were no spaces where you could say this is mere corona, for at a greater distance than the apex of the highest flame I can hardly say there was any decided light. I don't think there was anything visible beyond 5′ of the limb, and the highest flame might have been probably 4′. I must confess I was extremely vexed not to see anything like the corona I expected; I should never have called this a corona at all. The basis of it was a seething mass of flames of a languid character; some of them so languid as to lose the spiral shape of flame and lie in heaps, and the intervals between them were apparently filled with gaseous material which might be illuminated by them. I do not think the disk was ever entirely free from cloud during totality. There were certainly no streamers, so I conclude they must have been intercepted by the cloud. I do not mean merely that their light was, but their cause also; for I assume that the shadow of the Moon must inevitably chill and condense much floating moisture in our own air, and send it down as dew. And these falling particles would reflect the light emitted by the prominences, and the effect of perspective would give them an appearance of radiating beams from the Moon's limb, or rather from that neighbourhood, although the regularity of radiation might be interfered with by various terrestrial causes. I conclude that the dew which would have formed streamers was, at Augusta, intercepted or prevented by the cloud; although the latter was not dense enough to conceal much. I have often seen *Jupiter's* belts beautifully through a denser cloud certainly. I did not see *Saturn* on this occasion, it is true. I must confess, however, that I entirely forgot to look for him, my attention being too intently fixed on the subject of the corona.

The view, on the whole, I suppose lasted about ten seconds, but my drawing,* though necessarily done afterwards, gives a very fair general representation of what I saw. I marked down the positions of three chief prominences, and went again to the small telescope to seek for streamers, but found none, and the Sun almost immediately burst forth, compelling me to quit the instrument.

* The drawings referred to in this paper will be published by the Organising Committee with the rest of the Report.

On the Photographs taken at Syracuse during the Eclipse of the Sun, December 22nd, 1870. By Mr. Brothers.

The pre-eminent use of photography for determining points in dispute has seldom perhaps been so plainly seen as in its application to astronomical matters. First of all, in 1860, Dr. De La Rue and Father Secchi settled the question as to the prominences belonging to the Sun; and now, ten years later, it may, I think, be said that photography has disposed of the corona as one of the Sun's appendages.

The variety of drawings which have been published, no two pictures of the same eclipse ever agreeing in all particulars, conclusively showed that to photography must we look if we wished to obtain evidence which should be beyond dispute. The success of Dr. Curtis and Mr. Whipple had proved that more of the corona could be photographed than had previously been shown on the sensitive plate. But much remained to be shown — the eye could see more than had ever been photographed.

In considering the means to be adopted for photographing the eclipse on Dec. 22nd last, the question occurred to me, Why have not the photographic plates shown the corona as it is visible to the naked eye? And the answer appeared to be that the proper kind of instrument had not hitherto been used. An ordinary telescope, whether reflecting or refracting, is not suitable for the purpose. It would be of very little importance whether the image were large or small if only the corona in all its detail could be shown on the collodion plate; and yet the image of the Moon's disk must be of such dimensions that a good enlargement from it could afterwards be made. What was required was a *picture* of the eclipse, and it seemed to me that such a picture could only be taken with an ordinary photographic lens; one of long focus, and yet capable of giving an image with a moderately short exposure. Through the kindness of Mr. Dallmeyer, one of his "Rapid Rectilinear" lenses was lent me for the purpose of the Expedition, and with that instrument my pictures of the corona were taken. This lens is of 4 inches aperture, 30 inches focus, and gives an image of the Sun of about three-tenths of an inch in diameter. The image bears enlargement to $1\frac{1}{2}$ inches diameter with very good definition, notwithstanding the doubling of the image caused by the high wind which was blowing at the time the photographs were taken.

I have no doubt that good pictures of the corona could be obtained with a lens of still shorter focus, better probably than any hitherto taken; and in proof of this I have here three pictures of the eclipse taken by one of my assistants at Manchester with a lens of 16 inches focus and 4 inches aperture, giving an image $\frac{1}{8}$-inch in diameter. The copies now before you are enlarged four diameters and the definition is good.

It is proposed this evening to show on the screen, by means of the lime-light, transparencies of four of the negatives taken at

Syracuse during the totality. The plates were exposed in the following order, and with the results stated:—

		Seconds of Totality.	Results.
Spare time	3		
First exposure	3	3rd to 6th	Blank
Change plate	6		
Second exposure	18	12th to 30th	Fair
Change plate	6		
Third exposure	30	36th to 66th	Slight
Change plate	6		
Fourth exposure	15	72nd to 89th	Fair
Change plate	6		
Fifth exposure	8	95th to 103rd	Good
Spare time about	3		
Total	104		

The sixth plate taken in the telescope and exposed at the 36th second, for 3 seconds, for the prominences, gave no satisfactory result.

It is extremely difficult to describe the differing appearances of the pictures, but attention may be directed to two or three points. It will be noticed that the cloud which at one time threatened to prevent any photographs being taken, has obscured many of the details which are shown in the fifth plate; but the red prominences, shining with light of much greater photographic intensity than the corona, have left their impressions on the plates, and some of them can be seen in all four. No. 2 has the two between which the great rift shows in the fifth photograph, and these two prominences are shown in all four plates; others were covered by the Moon in passing over the Sun's disk. In No. 3 the light of the corona is about equal on the east and west sides, and is scarcely at all visible on the north and south. In Plates 2, 4, and 5, however, it will be noticed that the preponderance of the corona is seen on the westerly side; and as No. 2 shows this effect, it may, I think, be assumed that it was real, and did not depend on the Moon uncovering the westerly side as she passed on her course.

The effect of the cloud in obscuring detail is seen when we compare No. 5 with the other plates. In this plate we notice as the chief feature a great rift or gap, just between two red prominences on the south-west side of the Moon's limb; and there are also gaps distinctly marked on the east and west sides, with indications of similar features in other places. It may, perhaps, be suggested that these rifts are not visible in any of the other plates because the rifts were formed only at about the time the fifth picture was taken. This cannot, however, have been the case, as the great rift is seen in the same relative position on the plate

taken by the American photographers at Cadiz, and which was exposed during 1½ minute, or nearly the whole time of the totality. Now if this phenomenon had not been persistent, and only became visible during the last 20 seconds of totality at Cadiz, it could not have been shown at all, as the picture would have been "burnt out" at this part, and no dark space could have been shown.

The great rift in the corona is more distinctly shown in the original negative than in the transparency, which will be exhibited on the screen. The copy is made by transmitting light through the negative, and the consequence is that much of the finer detail is lost. When, however, the negative is viewed by reflected light it is seen that the corona extends on the north and westerly sides to at least two diameters of the Moon, and on the east and south sides to about one diameter.

When the original negative is viewed by transmitted light it exhibits features which I have endeavoured to show, though very imperfectly, in the copy of a drawing which will be exhibited on the screen. There are some places where there has been a greater intensity of light extending in one place about 10′ from the Moon's limb, and near this part there are other dense portions of varying height, and these rayed portions of the corona are of various forms, some are slightly curved in one direction and some in another. Most of this detail is lost in the process of copying; the general effect only will be seen on the screen. Photography cannot reproduce its own work in this case; and no words can accurately describe what this negative shows. It may perhaps be possible to reproduce some of the detail in a pencil drawing.

I do not venture to offer any opinion as to the cause of the rifts or dark spaces in the corona, but of their coincidence in position when the various drawings and photographs are placed side by side there cannot be the slightest doubt. This I shall endeavour to show on the screen when it will be noticed that Prof. Watson's drawing, and the American and my own photographs exhibit coincidences of a very remarkable character.

The following remarks on the subject, contained in a letter from Sir J. Herschel, will I am sure be considered valuable:—

"Assuredly the decidedly marked notch or bay in both photographs (those taken at Cadiz and Syracuse) agreeing so perfectly in situation (marked so definitely by its occurrence just opposite the middle point between two unmistakable red prominences) is evidence not to be refused of its extra atmospheric origin, and *almost* conclusive of its proximity to the solar globe. I see nothing which gives me the idea of rays or streaky irradiation such as that figure in the Washington Observations for 1870—Plate XII.—which, if it *could* be believed, would point to lunar mountains as the origin of the dark spaces, and bring the whole phenomenon within the distance of the lunar orbit. A terrestrial atmospheric origin is quite out of question."

On the subject of the effect of the outer corona being due to

atmospheric glare, I have received the following letter from Prof. Balfour Stewart, who says:—

"In the case of the uneclipsed Sun we have the well-known luminosity surrounding his disk, caused no doubt by atmospheric glare, so that here we may be said to have sunlight *plus* glare; when, however, the Sun is totally eclipsed, the light which we see is derived not from the body of the Sun himself but from his appendages, and the atmosphere acting in the same way upon this light as it did upon that of the uneclipsed Sun we have a complex phenomenon before us consisting of solar appendages *plus* its atmospheric glare.

"Now I see no reason why the proportion between the real light and the glare should not be the same in both these cases; that is to say, light of the Sun *is to* its glare *as* light of the solar appendages *is to* its glare. Taking your photograph as a trustworthy record of what was visible at the late eclipse, let us endeavour to ascertain how much of the photographic effect is due to atmospheric glare. I think I am right in stating two things with regard to this photograph. In the first place, the details of the luminous appendages surrounding the Sun are well represented. Secondly, there is little or no photographic effect over the centre of the Moon's disk. Judging from the photographs of the Sun himself taken by the Kew heliograph, we may conclude that when those pictures are not overdone, but give the various details of the solar disk, the exposure has been too small to give us the faintest trace of atmospheric glare which surrounds the Sun. Making use of the proportion above stated I should conclude that a photograph of the solar appendages not overdone but presenting, like yours, the details of these appendages, would not present a perceptible trace of their atmospheric glare.

"In the next place, the atmospheric glare due to the light from the eclipsed Sun should be thrown *inwards* over the Moon's disk as much as *outwards* beyond the true corona, the light therefore which reaches us in a total eclipse from the centre of the Moon's disk, and which may be partly due to earth-light reflected from the Moon, may be safely taken as somewhat exceeding that which can possibly be due to atmospheric glare; and inasmuch as in your photograph there is very little effect in the centre of the Moon's disk, I am led to think that very little of the result obtained can be due to glare.

"I have here confined myself strictly to your photographs, but the principle laid down is applicable to all kinds of observations; and I must confess that I cannot at the present moment see why the streamers, if they are caused by the atmosphere, should invariably shoot outwards and never venture to trespass upon the Moon's disk, at any rate this is a point that will bear discussion."

A careful examination of the original negative shows that the amount of deposit over the Moon's disk is equal to that shown at about $1\frac{1}{2}$ diameter from her limb, but this I believe to be due to

chemical deposit, and has nothing whatever to do with the action of light.

When prints from the second and fifth negatives are combined stereoscopically the effect of relief is produced. In the interval of 73 seconds, the Moon has changed her place sufficiently to show that the corona is not an atmospheric phenomenon. If it had not happened that the great rift, occurring between the two prominences shown so distinctly in the American and my own photographs, had decided the solar origin of the corona, these two photographs would probably have been sufficient for the purpose.

On the Zodiacal Light. By A. C. Ranyard, Esq.

The conviction that the accumulation and comparison of evidence on a subject so interesting and yet so little understood as the zodiacal light cannot but be useful, induces me to submit the following observation to the notice of the Astronomical Society:—

On the evening of the 19th December last the detachment of the Eclipse Expedition encamped at Agosta had an opportunity of examining a particularly brilliant display of the zodiacal light, stretching to some 80° from the Sun's place: its contour was of a somewhat conical form, blunted at the apex, the semi-vertical angle of the cone being about 12°. Its light was apparently white, and was undistinguishable in point of colour from the light of the Milky Way, which also shone out with considerable distinctness upon the night in question. I was anxious to see if any polarization could be detected, and for this purpose made use of a Savart, and at first thought that faint lines were visible, indicating polarization in a plane through the Sun; but not being at all sure of my observation, I asked Mr. Burton, who was formerly assistant to Lord Rosse, and has very keen eyesight, to look through the instrument: he at once said that he distinctly saw bands brightest when the Savart was turned so that the direction of the bands passed through the Sun, and that the centre band was black; he also saw the bands perpendicular to the Sun's direction, but could not determine the nature of the centre one. I should mention that the Savart was so set as to give a black centre when the bands were parallel to the plane of polarization.

I then asked Mr. Burton to see if he could detect any bands upon the sky away from the zodiacal light, but he was unable to do so even at 90° away from the Sun's position.

I again took the instrument, but was unable to see any bands myself. On the next night the zodiacal light was again visible, but with considerably less brilliance than before. Father Secchi observed it with a Savart, and thought that he detected faint bands, but said that he could not be sure of his observation.

If other observations should confirm those of Mr. Burton we shall be in possession of proof, not only that the zodiacal light consists of matter which reflects the Sun's light, but that—

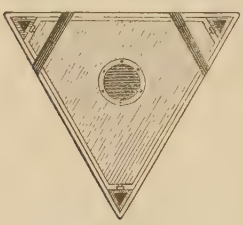
(1) That matter exists in particles so small that their diameters are comparable with the wave-lengths of light; or

(2) It consists of matter capable of giving specular reflection.

On a Contrivance for protecting the Observer when a Reflecting-Telescope of large size is used in the open air. By J. Browning, Esq.

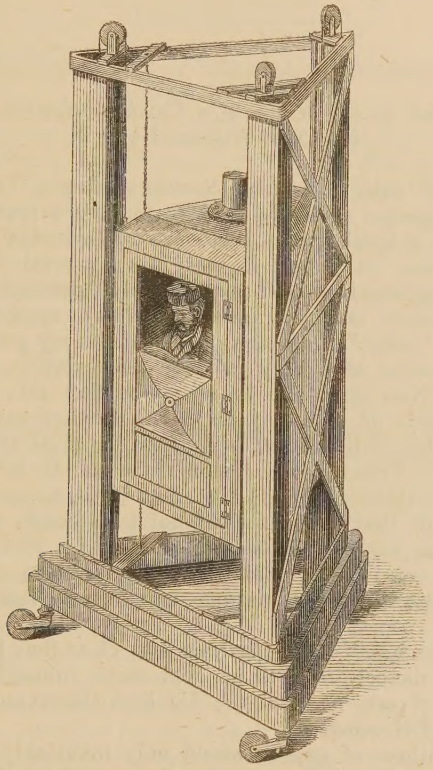
It is generally admitted that reflecting-telescopes of large aperture perform most satisfactorily when they are used in the open air; the currents caused by convection, when the instrument is protected, through the slit of the dome of the observatory, being very prejudicial to good definition. But it is, of course, very desirable that the observer should be protected from winds and cold, particularly when measuring or drawing. I have contrived what I prefer to term "an observing-box," which I think will be found useful, inasmuch as it will afford complete protection to the observer under all circumstances.

The diagram which I shall now describe shows the principal details of this contrivance; but I have prepared a carefully executed model of the contrivance, so as to be able to exhibit the action to the members of the Society. In the diagram, A, A, A represent three triangular pillars, which are hollow. These are attached to B and C, two strong triangles, framed of quarterings.



The observing-box D, which is also triangular, fits loosely between the three upright pillars, and runs in grooves, placed on the sides which face inwards. The weight of the observing-box is supported by three ropes, which run over the pillars P, P, P, attached to A, A, A. These are carried down the hollow pillars, and weights, which collectively must be heavier than the box and the observer, are suspended from them. In this manner the weight of the box is counterbalanced. A door in one side of the box enables the observer to enter when the box is near the ground. On the lower ledge of the opening in this door, at a convenient height, a desk slope is placed; this can be lowered on hinges, or raised, and kept in position by a turning bracket in the usual way. The observer sits in an ordinary chair, as it has been found more comfortable than any seat attached to the box. Two strong cords attached to bars running across the triangles A and B, are carried through small circular holes in the top and bottom of the observing-box, one on each side of the observer. To raise or lower himself, the observer has only to take hold of

these, and if his weight is pretty accurately counterbalanced, a very slight exertion of force will enable him to ascend and descend readily to any height he may desire. In the portion of this apparatus which I have completed, I have found that a force of seven pounds was quite sufficient for this purpose. By having the weights, as I have stated, heavier than the box and the observer, and counterbalancing the box by superfluous weights on the inside, the box may be used by any person who is heavier or lighter than the observer for whom it was constructed. Ventilators with gauze wire, and sliding shutters which may be



opened or shut at the will of the observer, are placed on each side of him; as also a Miller's smoke-top, as a ventilator in the roof of the box. In particularly inclement weather, a cloth or India-rubber head may be attached to the framework of the door. This need have only a small circular opening, in which may be sewed a strong elastic band. On springing this over the eye-piece of the telescope, the observer will be protected from the weather. The same contrivance may also be used for the complete exclusion of all light. A foot-warmer filled with boiling

water, placed beneath the seat of the chair, or beneath the observer's feet, would enable him to heat the inside of the box to a temperature many degrees above that of the surrounding atmosphere, without impairing the performance of his telescope. Without the hood, and with all the ventilators open, the contrivances can also be used advantageously for solar observations, for protecting the observer from the heat and glare of the Sun. The whole of the scaffolding in which the box moves runs upon three castors.

Note on the Misuse of a Common Symbol.

By Capt. William Noble.

"In order," says Mill in his *System of Logic*, "that we may possess a language perfectly suitable for the investigation and expression of general truths, there are two principal and several minor requisites. The first is that every general name should have a meaning steadily fixed and precisely determined."

As this canon obviously includes a sign or symbol under the logical term "name," I am anxious to enter my protest against the misapplication of a very common abbreviation. I refer to the mark ″. Now there can be no doubt that this legitimately signifies seconds *of arc;* but, to go no further back than the January number of the *Monthly Notices*, I find at the bottom of p. 67 that Mr. Prince's Observatory is stated to be "24″ E. of Greenwich;" while, as a matter of fact it is 24 seconds *of time* to the East of that Meridian, and not 1·6 seconds, as would appear from the mode of expression employed. Well, two pages further on I read of Dr. Robinson observing the eclipse with a "7″ achromatic"! which, I assume, can only be intended for a 7 *inch* one.

As matters stand, it is anything but clear that Dr. Robinson did not view the eclipse with an achromatic subtending an angle of 7 seconds of arc, or that the Uckfield Observatory is not 24 inches East of Greenwich.

If the authors of papers would only invariably write "sec." for seconds of time, ″ for seconds of arc, and "in." for inches, all ambiguity would be avoided.

Occultation of η Cancri by the Moon, on Friday, March 3, 1871, observed at Forest Lodge, Maresfield. By Capt. Wm. Noble.

The star disappeared instantaneously at the Moon's

Dark Limb at $9^h\ 55^m\ 41^s{\cdot}7$ L.S.T. = $11^h\ 10^m\ 34^s{\cdot}7$ L.M.T.

The reappearance was not observed.

The telescope employed was my Rosse Equatoreal of 4·2 inches in aperture, with a power of 154, adjusted on the star.

Note on the Occultation of Uranus, on Thursday, March 2. By Capt. Wm. Noble.

The disappearance of *Uranus* was predicted, on p. 452 of the *Nautical Almanac*, to occur at $14^h\ 7^m$ S.T. Having adjusted my equatoreal (with a power of 255) on the planet, I went to the telescope at $14^h\ 5^m$ L.S.T., only to find that he had *already disappeared.* There would seem to be something in this requiring further explanation; as it is rare indeed—save in the case of *Jupiter's* Satellites—to find our National Ephemeris 2 minutes in error.

Note on the Distribution of the 324,000 Stars in Argelander's Charts. By Richard A. Proctor, B.A. (Cambridge).

I have commenced the work of isographically charting down all the stars shown in Argelander's noble series of maps. I am constructing the chart on Sir John Herschel's polar isographic projection described in my *Handbook of the Stars.* It will be necessary to divide the northern hemisphere into four quadrants, which will subsequently be carefully united into a single circular chart about $4\frac{1}{2}$ feet in diameter. The quadrantal charts will be submitted to the Society's attention as soon as they are severally completed; and photolithographic reductions of the full chart will eventually be provided for the inspection of the Fellows.

I need hardly say that several months (at least) must elapse before all the 324,000 stars are charted. Already, however, I have evidence strongly confirming the theories I have put forward respecting stellar distribution; and clearly demonstrating the importance of considering the details of such distribution, instead of averages as heretofore.

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